Treatment of blood blister–like aneurysm of the internal carotid artery with stent-assisted coil embolization followed by stent-within-a-stent technique

Case report

BYUNG MOON KIM, M.D.,¹ EUN CHUL CHUNG, M.D.,¹ SUNG IL PARK, M.D.,² CHUN SIK CHOI, M.D.,¹ AND YU SAM WON, M.D.¹

¹Department of Diagnostic Radiology, Sungkyunkwan University School of Medicine, Kangbuk Samsung Hospital, Seoul; ²Department of Radiology, Soonchunhyang University College of Medicine, Bucheon Hospital, Bucheon; and ³Department of Neurosurgery, Sungkyunkwan University School of Medicine, Kangbuk Samsung Hospital, Seoul, Republic of Korea

✓ Ruptured blood blister–like aneurysms (BBAs) of the internal carotid artery (ICA) are potentially dangerous lesions because of the high risk of intraoperative bleeding associated with their wide fragile neck. The authors discuss cases in which BBAs were treated endovascularly during the chronic stage and report a case in which a ruptured BBA of the ICA was successfully treated in the acute phase with stent-assisted coil embolization and a subsequent stent-within-a-stent procedure. (DOI: 10.3171/JNS-07/12/1211)

KEY WORDS • blood blister–like aneurysm • internal carotid artery • stent-assisted coil embolization

Ruptured blood blister–like aneurysms (BBAs) arising from the nonbranching sites of the ICA are rare (range 0.9–6.5% of all ICA aneurysms).³ These lesions are also commonly called ICA dorsal wall aneurysms, ICA anterior wall aneurysms, and ICA trunk aneurysms. They present with acute SAH and typically appear as small, hemispherically shaped bulges from the nonbranching site of the ICA anterior or anteromedial wall.⁷⁸ The optimum treatment of BBAs is still not known. Several cases of endovascularly treated BBAs during the chronic stage have been reported.⁵⁶,¹²

We report on a patient with a BBA who underwent a stent-assisted coil embolization and a subsequent stent-within-a-stent procedure during the acute phase.

Case Report

Examination. This 57-year-old woman was admitted to our institute with severe, sudden-onset headache. She had a history of hypertension but was not receiving medication. On neurological examination, we observed a confused mental state without focal neurological signs. Brain computed tomography scanning revealed diffuse SAH, with hemorrhage appearing predominantly on the left side. Left ICA angiography demonstrated a small hemispherical bulge at the anteromedial wall of the left supraclinoid ICA.

Because of its typical location and shape, this lesion was diagnosed as a BBA.

Operation. Initially, segmental occlusion of the left ICA bearing the aneurysm was considered, but because of the poor collateral circulation and the patient’s intolerance to a left ICA occlusion test, this option was abandoned. The placement of an aneurysm clip was also abandoned because of the high risk of intraoperative bleeding and technical difficulty. Subsequently, stent-assisted coil embolization was attempted. Because the patient was in the acute stage of SAH, although stent-assisted coil insertion was planned, no pretreatment antiplatelet therapy was administered. At the beginning of the procedure, anticoagulation was initiated by injecting a bolus of 5000 U of heparin intravenously, followed by continuous infusion of heparin by rate of 1000 U/hour. Heparin was continued for 48 hours after embolization, and activated coagulation time was maintained between two- and threefold above the normal value.

A 7-F guiding catheter (Enboy, Cordis) was positioned at the distal cervical portion of the left ICA. The left middle cerebral artery was navigated using a microcatheter (Excelsior-10, Boston Scientific) and a 300-cm guidewire. A 4.5 × 15-mm, self-expandable stent (Neuroform-3, Boston Scientific) was advanced over the prepositioned wire and deployed into left distal ICA, covering the aneurysm neck. After we selected the aneurysm sac using a microcatheter, two ultrasoft helical Guglielmi detachable coils (total length 3 cm) were inserted into the aneurysm sac. A second 4.5 × 20-mm Neuroform-3 self-expandable stent...
was also inserted using a stent-within-a-stent technique to support the fragile aneurysm neck and to decrease flow impingement. Postembolization angiography revealed complete occlusion of the aneurysm sac.

Postoperative Course. The postoperative clinical course was uneventful, and the patient’s clinical condition gradually improved. Her Glasgow Outcome Scale score was 5 at discharge. She underwent dual antiplatelet therapy (aspirin 100 mg and Plavix 75 mg) for 6 months. The follow-up angiograms obtained 2 weeks and 3 months later demonstrated complete occlusion of the aneurysm and preservation of the ICA (Fig. 1). A six-month follow-up angiography revealed a radiolucent membrane between the coil mass and smooth ICA wall, suggesting complete healing of the aneurysm (Fig. 2).

Discussion

The BBA is a rare but clinically important cause of SAH, comprising 0.5% of ruptured intracranial aneurysms. A BBA typically appears as small, hemispherical bulge at the anterior or anteromedial wall of the supraclinoid ICA. Its pathogenesis is not well understood. In autopsy studies of similar cases, several authors have demonstrated that these lesions are focal wall defects covered with thin fibrous tissue and are therefore not true aneurysms. Dissection of the ICA was observed in 40 to 89% of the patients with BBAs, suggesting the presence of specific pathological features in BBAs and that dissection of the ICA may be a causative factor. Additionally, hemodynamic stress seems to be important in the formation of BBAs because the anteromedial wall of the supraclinoid portion of ICA is curved where the flux of blood flow impinges on the arterial wall. However, whereas hemodynamic stress may be a common causative factor in both BBA and saccular-type aneurysm formation, pathological changes in BBAs are more destructive than those in berry aneurysms. Stanson et al. have described an ulcerative atherosclerotic lesion at the aortic wall just distal to the subclavian artery origin, where the flux of blood flow impinges on the aortic wall as on the anteromedial wall of ICA. This lesion penetrated the internal elastic lamia, designated as a penetrating athrosclerotic ulcer. This may have been a focal dissection, but it exhibits different clinical features. We infer from these findings that a penetrating ulceration with focal wall defect combined with hemodynamic stress may play an important role in the development of an ICA BBA.

The optimum treatment for BBAs remains uncertain. The outcomes reported in most surgical series have been poor because of the incidence of intra- and postoperative aneurysm bleeding. A few cases of BBA, treated endovascularly, have been reported. McNeely et al. described one case in which a BBA was treated by endovascular embolization after it was wrapped. Tanoue et al. treated a BBA with a pseudoaneurysm by undertaking delayed coil embolization. Islam et al. reported staged endovascular treatment for BBAs in which coil embolization in acute phase was followed by proximal occlusion with extracranial–intracranial bypass surgery in the chronic stage. In these three cases, the aneurysms grew naturally, grew after surgical wrapping, or grew after coil embolization. These findings indicate the very nature of the BBA, reflecting the extremely fragile wall of this lesion. In our case, we treated a BBA in the acute phase, conducting stent-assisted coil embolization because of the typical appearance of a BBA with small hemispherical bulge. Regrowth of the aneurysm after treatment, which is frequent in cases of BBAs, may require extracranial–intracranial bypass surgery be-

![Fig. 1. Studies of an ICA aneurysms before and after treatment. A: Oblique 3D reconstruction of a left ICA angiogram demonstrating a small hemispherical bulge at the anteromedial wall of supraclinoid portion of the artery. Focal irregularity of the wall just distal to the lesion is also seen. B: Left oblique ICA angiogram obtained after stent-assisted coil embolization followed by a stent-within-a-stent procedure. The image shows a completely occluded aneurysm sac. C: Three-dimensional reconstruction of a left ICA angiogram acquired immediately after endovascular treatment, revealing the occluded aneurysm sac and smoothing of the wall where focal irregularity was noted. The radiopaque stent markers are seen as high attenuation spots along the carotid artery wall. D: Follow-up left ICA angiogram obtained 3 months postoperatively revealing complete occlusion of the aneurysm sac and the smooth wall above the occluded aneurysm sac.](image1)

![Fig. 2. Follow-up angiographic studies acquired 6 months after treatment. The 3D reconstruction (left) and native angiogram (right) demonstrate a radiolucent membrane across the aneurysm neck between the coil mass in the aneurysm sac and the smooth ICA lumen.](image2)
Stent-assisted coil embolization of an ICA blisterlike aneurysm

cause of the ICA sacrifice. Therefore, we inserted an additional stent into the ICA using the stent-within-a-stent technique to provide additional support of the fragile aneurysm neck and to decrease flow impingement, and also because we anticipated that this measure would accelerate aneurysm thrombosis and healing. The results were good. A follow-up angiography 6 months after treatment demonstrated a radiolucent line crossing the aneurysm neck, separating the coil-filled aneurysm sac from the smooth ICA lumen. This finding suggested that the aneurysm neck was completely covered by a healing membrane. In our opinion, the stent-within-stent procedure significantly contributed to the healing membrane that formed across the aneurysm neck. Recently, Fiorella et al. reported 10 cases of intracranial pseudoaneurysms, including two cases of BBAs. Because the aneurysms either lacked a defined saccular component or the associated saccular component was too small to accommodate coils, the surgeons used, respectively, one and three Neuroform stents alone to treat the BBAs. Their good results also support the favorable effect of stents on BBA treatment. Because BBAs have a shallow sac and very fragile neck, even stent-assisted coil therapy may be difficult and have potential associated risks—of either aneurysm neck disruption or distal coil migration. In cases of BBAs in which even stent-assisted coil deployment is impossible, in our opinion, multiple-stent insertion may be an option.

Covered stents may be another option. We did not, however, attempt to use them because they have several limitations. A covered stent is far stiffer than a bare stent. Thus, the delivery of this device into the intracranial ICA is very difficult, especially in an ICA’s tortuous cavernous portion. Because the BBA is usually located at the anterior or anteromedial convexity of the supraclinoid ICA, a stiff covered stent may impinge on the fragile aneurysm neck portion during the delivery, resulting in an unwanted outcome. In addition, a covered stent may be too stiff to fully conform to the curved intracranial ICA wall, resulting in failure of the aneurysm sealing.

Conclusions

In the present case, the ruptured BBA was successfully treated in the acute phase by endovascular surgery. Stent-assisted coil embolization followed by a stent-within-a-stent procedure may be a treatment option for these rare but high-risk aneurysms.

Disclaimer

The authors will not benefit financially from any device mentioned in the text.

References


Address correspondence to: Byung Moon Kim, M.D., Department of Diagnostic Radiology, Sungkyunkwan University School of Medicine, Kangbuk Samsung Hospital, 108 Pyung-Dong, Jongro-Ku, Seoul 110-746, Republic of Korea. email: bmoon21@hanmail.net.